

At right, a researcher is inserting a sample into a BEEM (Ballistic Electron Emission Microscopy) system, described as a system that allows scientists to peer into the electronic structures of semiconductor devices. **below** are the components of the BEEM system, which was developed at Jet Propulsion Laboratory (JPL), engineered by Atomis, Inc., Berkeley, California and introduced to the commercial marketplace by Surface/Interface Inc., Mountain View, California.

BEEM is a research instrument invented by a trio of scientists at JPL's Center for Microelectronics Technology: Douglas Bell, Michael H. Hecht and William J. Kaiser. The invention won for the trio an R&D 100 Award in 1990 because of the significance of the technology to microelectronic research. Analytical instruments that produce images of surface structures are in wide use, but BEEM goes a step further with the ability to image underlying layers or interfaces.

BEEM was conceived as a tool for advanced research on semiconductor devices. Co-inventor Michael Hecht says that "almost everything of interest in semiconductor devices happens at interfaces, not on surfaces." BEEM injects a tiny current into a metal layer and the electrons travel ballistically through the metal; this allows

the researcher to look at the interface and surface simultaneously to study the operation and performance of a structure.

Among BEEM advantages cited by JPL are the option to inject either electrons or holes to nondestructively image barrier heights and characterize devices electronically; the ability to image interface and surface using an instrument that operates in air, liquid or in a vacuum; and the potential to observe processes such as molecular beam epitaxy (crystal growth) in situ.

